



# Science 8

## Module 3

# Light and Optical Systems

## HOME INSTRUCTOR'S GUIDE AND ASSIGNMENT BOOKLET 3A



Science 8  
Module 3: Light and Optical Systems  
Home Instructor's Guide and Assignment Booklet 3A  
Learning Technologies Branch  
ISBN 0-7741-2371-0

**The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Home Instructor's Guide and Assignment Booklet.**

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	✓
General Public	
Other	



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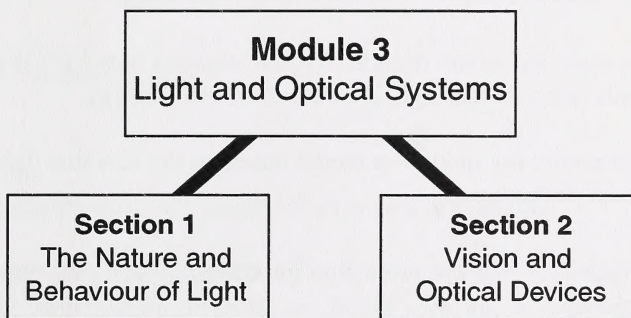
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## Module 3: Light and Optical Systems

The major emphasis of this module is the Nature of Science. This emphasis deals with the processes by which scientific knowledge are developed and tested, and on the nature of scientific knowledge itself.

Much of the time people's understanding of the world is based largely on what they see—both directly and aided by optical devices that improve and extend vision. Such tools as the microscope and telescope have helped to extend knowledge in a variety of science fields from the study of cells and stars to studies of the nature of light itself.

In learning about light, students investigate its interactions with different materials and interpret its behaviour by using a geometric ray model. Students then use their understanding of light to interpret a variety of light-based technologies.



## Assessment

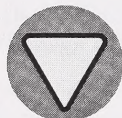
The assessment of this module will be based on two Assignment Booklets. These will be weighted as follows:

<b>Assignment Booklet 3A</b>	
<b>Section 1 Assignment</b>	<b>48 marks</b>
<b>Assignment Booklet 3B</b>	
<b>Section 2 Assignment</b>	<b>32 marks</b>
<b>Final Module Assignment</b>	<b>38 marks</b>
	<hr/>
<b>TOTAL</b>	<b>118 marks</b>

## Section 1: The Nature and Behaviour of Light

In this section, students study the nature of light. By investigating how light is produced, transmitted, and transformed, students discover that light is a form of radiant energy.

Students also use the geometric ray model—a model based on the idea that light travels in straight lines or rays—to predict optical phenomena.



Safety goggles provide eye protection for students when they do activities or investigations.

The apparatus and materials needed are listed under each lesson. In planning ahead you will find it useful to preview these lists.

The following materials will be needed to complete this section.

### Section 1: Lesson 1

- a solar-powered calculator, if possible
- two identical black film canisters
- aluminum foil
- a book
- a lamp without a shade
- a 60 W light bulb
- a 100 W light bulb
- measuring tape
- a sharp knife
- a large cardboard box
- masking tape

## Section 1: Lesson 2

- a ray box, if possible

**Note:** A ray box is an electrical device that emits a thin beam of light. A ray box can be obtained from a laboratory supply company.

- a small plane flat mirror (5 cm by 5 cm)
- a protractor
- a ruler
- a pencil
- a sheet of blank paper

## Section 1: Lesson 3

- a cup or bowl of opaque material
- water
- a coin
- a plastic cup with transparent sides
- a wooden pencil
- a ruler
- a ray box, if possible
- a transparent watertight tray—only needed if a ray box is available
- a protractor
- three sheets of letter-size white paper
- liquids other than water, such as vegetable oil, liquid soap, and liquid honey that are non-toxic and non-corrosive—only needed if a ray box is available

**Note:** Use only common household liquids. After they have been used in the investigation, they may be disposed of by flushing them down the toilet or by other sensible methods.

## Suggested Answers

### Section 1: Lesson 1

#### 4. Textbook questions 1 to 7 from “What Did You Find Out?” and “Extensions,” page 177:

1. With no backup battery in the calculator, the digits disappeared when light was prevented from reaching the solar cell. With a backup battery no change is noted. Students will be able to conclude whether their solar calculator has a backup battery.

2. The canister felt warmer after being exposed to the light.
3. Evidence that light caused a change in steps 1 and 2 of “Procedure” are the following:
  - The calculator digits disappeared when light was prevented from reaching the solar cells.
  - The temperature of the black canister increased as compared to no temperature change for the covered canister.
4. Light energy absorbed by the solar cells is changed into electrical energy.
5. “Light can be changed into energy forms such as electrical and thermal energy.”
6. The manipulated variable is the surface condition—or how reflective the surface is—of the canister.

The responding variable is the temperature of the canister wall.

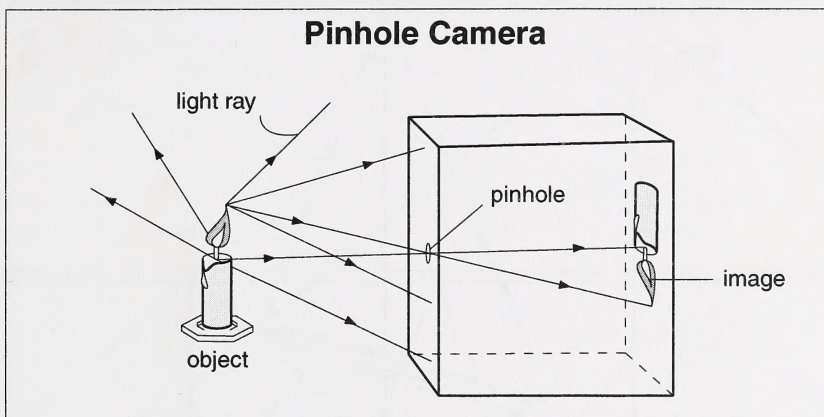
The following variables need to be controlled:

- distance from the light to the canister
  - the same light source
  - the time exposed to light
  - the same initial canister temperature
  - a single layer of aluminum foil in close contact with the canister wall
7. The canister with the aluminum foil cover does not warm up as much as the one without foil. The shiny, light-coloured aluminum foil is a good reflector, so very little light energy is absorbed. The dull, dark plastic canister is a good energy absorber and converter of light to heat.

**15. Textbook questions 1 to 4 from “What Did You Find Out?” on page 186:**

1. The brightness of the image increases when the object is closer to the camera.
2. The size of the image increases when the object is closer to the camera.
3. The sharpness of the image decreases when the object is closer to the camera.

4. Answers will vary. If light did not travel in straight lines, it would not produce an upside-down image. Light radiates in all directions from the source—only the rays that travel in a straight line to the opening are able to enter the pinhole camera. The rays from the top of the object are travelling at a downward angle, so they strike the screen below those travelling at an upward angle from the bottom of the object. Check the following diagram.



**16. Textbook questions 1, 4, 6, and 7 from “Topic 1 Review,” page 187:**

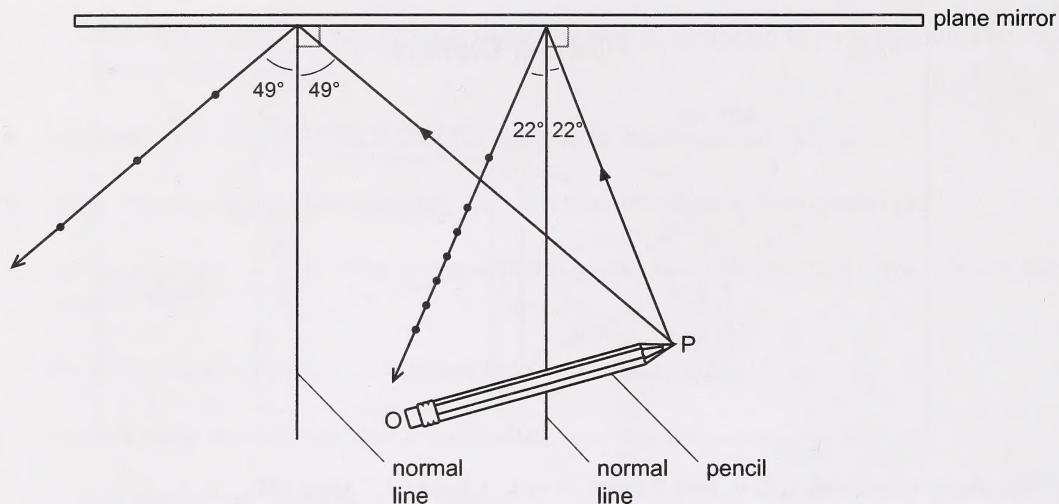
1. Light is a form of radiant energy that stimulates vision.
4. Fluorescent tubes convert less electrical energy into heat energy than do incandescent bulbs. Therefore, the tubes can be safely touched while they are turned on, and they are also more energy efficient than the bulbs.
6. A translucent medium, such as waxed paper, transmits only diffused or scattered light—people cannot clearly see through it. A transparent medium, such as clear glass, transmits light without apparent change—people can clearly see objects through it. For both translucent and transparent mediums, some light is reflected and a very small amount of light is absorbed.

No light is transmitted through an opaque object, such as a rock or a block of wood. All light is either reflected or absorbed by the substance.

7. The intensity of light depends on the brightness of, and distance from, the source. Therefore, if Earth were twice as far from the Sun, the sunlight’s intensity would decrease.

**Section 1: Lesson 2**

3. The angle of incidence and the angle of reflection should be the same size for each incident ray. Allow for small measuring errors of one or two degrees. See the diagram for an example.

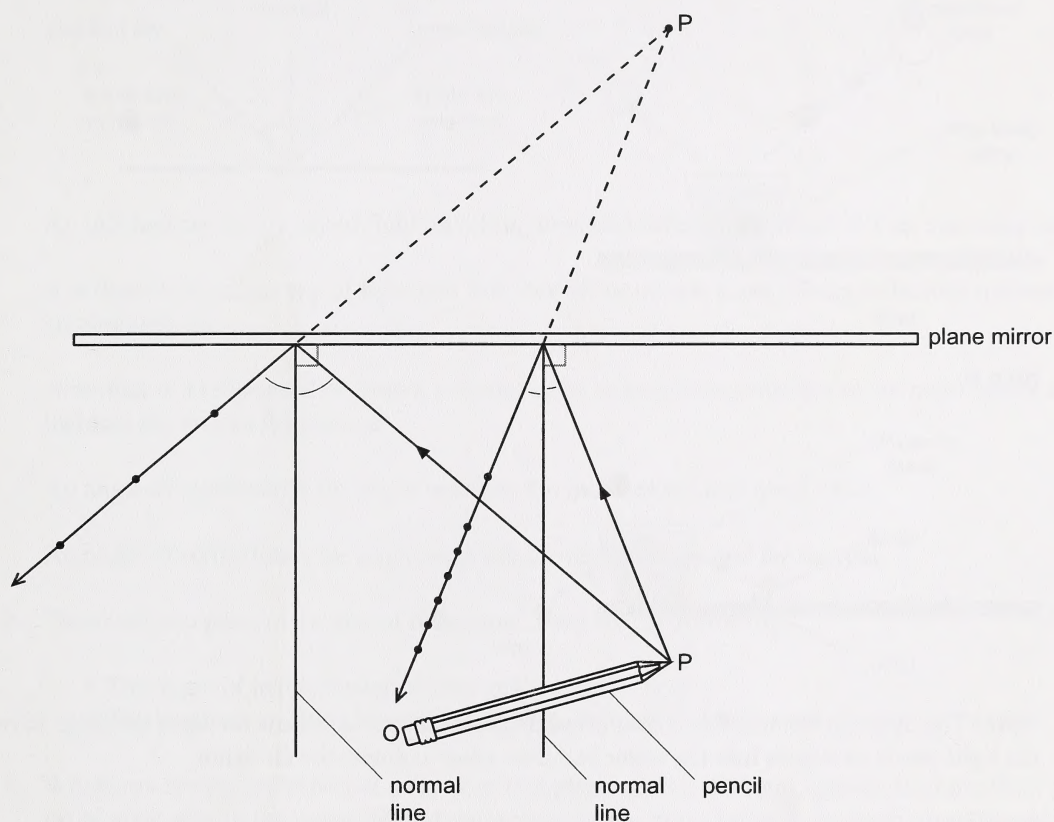


4. Textbook questions 2 and 3 from “Analyze,” page 191:

2. The angle of incidence equals the angle of reflection.

3. Answers will vary. A sample diagram is included.

### Inferring the Laws of Reflection



The distance from the mirror to the object and from the mirror to the image should be equal. In the above diagram these distances are close to 5 cm.

### 5. Textbook questions 5 and 6 of “Conclude and Apply:”

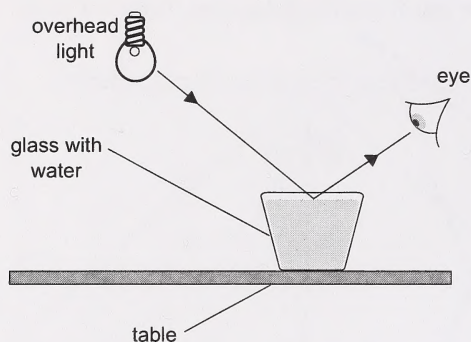
5. A flat surface is called a plane.

The incident ray, reflected ray, and normal all lie in the same plane. **Note:** This special relationship is the second law of reflection.

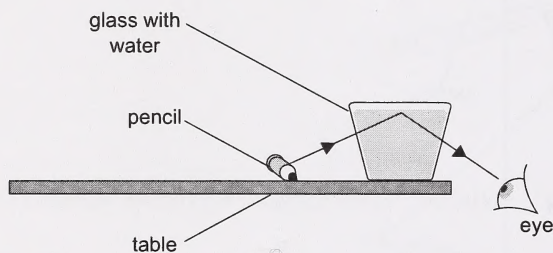
6. The distance from the image to the mirror is equal to the distance from the object to the mirror.

## 6. Textbook questions from steps 3, 6, and 7 of “Procedure,” pages 192 and 193:

### Step 3



### Step 6



**Note:** The diagram for step 6 is a simplified diagram. It does not show the light bending. In reality, the light bends as it goes into the water and then when it enters the air again.

### Step 7

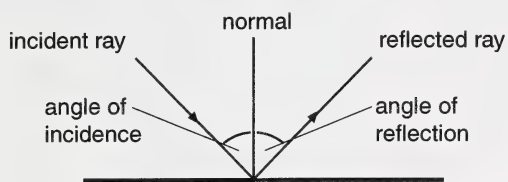
The water surface becomes rippled. The image becomes unclear and may even disappear.

## 7. Textbook questions 1 to 3 from “Analyze” and “Conclude and Apply,” page 193:

1. In steps 4 and 6 of “Procedure,” some of the light that struck the lower surface of the water was reflected. A mirror is a common device that depends on this behaviour of light.
2. When the student tapped the glass, the water surface rippled. The uneven, and moving, surface did not produce a clear image.
3. Light changes direction during reflection. The reflected ray travels away from the point of incidence. The angle of reflection is equal to the angle of incidence—this is the first law of reflection.

**13. Textbook questions 1 to 3 from “Topic 2 Review,” page 199:**

- Students should make a drawing similar to the following.



An incident ray is any ray of light travelling toward a reflecting surface. It's an incoming ray.

A reflected ray is any ray of light that bounces off or travels away from a reflecting surface. It's an outgoing ray.

A normal is a reference line drawn perpendicular to a reflecting surface at the point where an incident ray strikes the surface.

An angle of incidence is the angle between the incident ray and the normal.

An angle of reflection is the angle between the reflected ray and the normal.

- There are two parts to the law of reflection. They are the following:
  - The angle of incidence equals the angle of reflection.
  - The incident ray, the reflected ray, and the normal lie in the same plane.
- When you see the reflection of your nose in a plane mirror, the light appears to come from the tip of your nose in the image behind the mirror. If you move twice as far away from the mirror, the position of the image appears to be twice as far behind the mirror.

**Section 1: Lesson 3**

- The speed of light in air is 300 000 km/s, in glass it's 200 000 km/s, and in diamonds it's 165 000 km/s.
  - As the density of a material increases, the speed at which light travels through it will decrease.
- Due to refraction, the apparent position of the fish is higher in the water than the actual position of the fish. An inexperienced bear will probably swipe too high in the water. With experience, the bear will likely learn to swipe below the apparent position of the fish.

5. a. The ray is refracted or bent away from the normal line at A. This indicates that light travels faster in the prism than it does in water.
- b. At B, the ray will follow path 2. It will be refracted toward the normal line. The refracted ray will follow a path parallel to the incident ray at A.
6. Answers will vary.

The manipulated variable (MV) is the density of the transmission medium.

The responding variable (RV) is the angle of refraction.

Some controlled variables (CVs) are the

- angle of incidence
- shape and size of the container
- intensity of light
- size of the light beam

7. Answers will vary. The following are suitable questions.

Does light bend toward or away from the perpendicular in going from air into more dense material?

Does the amount of bending increase when the beam is at a greater angle of incidence?

How does the direction of light change in going from air into the container and out again?

8. Answers will vary. As the density of the transmission medium increases, the refraction of the light away from the normal will decrease because the speed of the light will decrease.

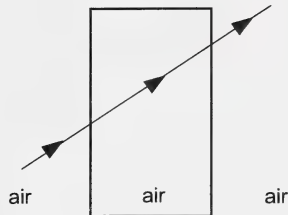
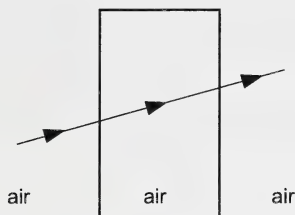
**Note:** Check that the hypothesis includes a reason that is plausible.

9. Answers will vary. Here is a sample student procedure.

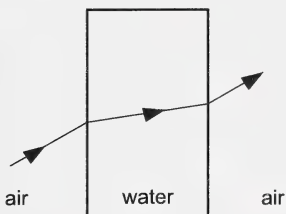
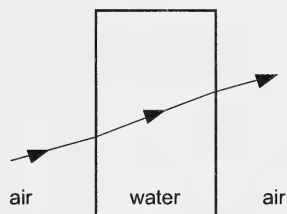
I would fill the container with various liquids. I would send the light into the container at a constant angle of incidence. I would use water, oil, and solutions to see how the angle of refraction was affected.

10. Answers will vary. The following are some examples.

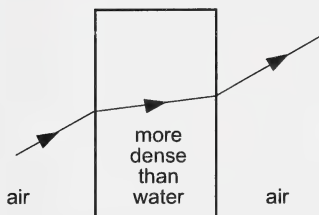
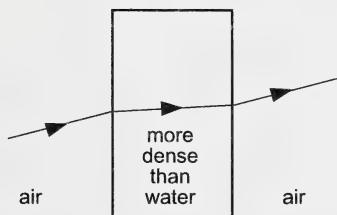
(a)



(b)



(d)

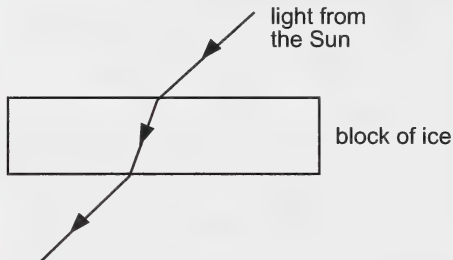


11. Textbook questions 2 and 3 from “Analyze,” page 203:

Answers to questions 2 and 3 of “Analyze” will vary depending on the angle of the incident ray and the medium used. The diagram should look like the diagram given in question 11 of the Student Module Booklet.

**12. Textbook questions 1 to 5 from “Topic 3 Review,” page 206:**

1. In reflection, light bounces off a surface back into the same medium. In refraction, light is bent as it passes through a surface into another medium.
2. Answers will vary. Glass and water refract light. Reflection and absorption also occur to some extent.
3. When light is refracted it changes speed and bends toward or away from the normal.
4. (a) Light moving from air into glass slows down and bends toward the normal line.  
(b) Light moving from water into air speeds up and bends away from the normal line.
5. The path of a ray of sunlight through ice follows in this diagram.



# ASSIGNMENT BOOKLET 3A

Science 8  
Module 3: Section 1 Assignment

Home Instructor's and Student's Comments:

**STUDENT FILE NUMBER**  
(if label is missing or incorrect)

Date Submitted:

Apply Module Label Here

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Date Assignment Received:

Grading:

Teacher's Comments

Teacher's Signature

Home Instructor: Keep this sheet when it is returned to you as a record of the student's progress.

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- Are all the assignments completed? If not, explain why.
- Has your work been reread to be sure the spelling and details are correct?
- Is the record form filled out and the correct module label attached?

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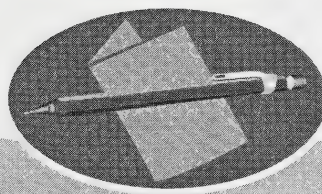
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# **Science 8**

## **Module 3**

### **Light and Optical Systems**

#### **ASSIGNMENT BOOKLET 3A**



## FOR TEACHER'S USE ONLY


### Summary

	Total Possible Marks	Your Mark
Section 1 Assignment	48	
	48	

### Teacher's Comments

Science 8  
Module 3: Light and Optical Systems  
Assignment Booklet 3A  
Section 1 Assignment  
Learning Technologies Branch

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**ASSIGNMENT BOOKLET 3A**  
**SCIENCE 8: MODULE 3**  
**SECTION 1 ASSIGNMENT**

Your mark for this module will be determined in part by how well you do your assignments.

This Assignment Booklet is worth 48 marks out of the total 118 marks for the assignments in Module 3. The value of each assignment and each question is stated in the left margin.

Work slowly and carefully. If you have difficulty, go back and review the appropriate section.

Be sure to proofread your answers carefully.

48

**Section 1 Assignment: The Nature and Behaviour of Light**

**Read all parts of your assignment carefully and record your answers in the appropriate places.**

1

1. Circle the letter of the best response.

What type of energy is least like light energy?

- A. infrared
- B. sound
- C. microwave
- D. X-ray

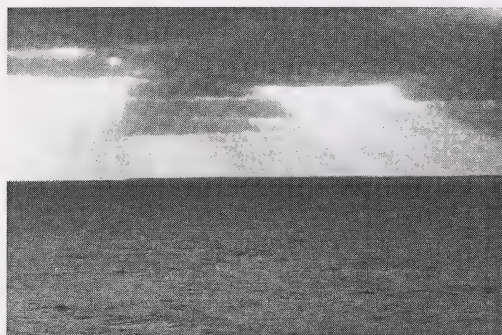
2

2. List two sources of artificial light used in homes and offices.

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Use the following photograph to answer question 3.



CORBIS

①

3. What do the sunbeams indicate about light?

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4. Chemiluminescence makes glow sticks give off light.

①

- a. What is the energy pathway for chemiluminescence? Draw the pathway or describe it.

③

- b. How does this energy pathway compare to the energy pathway for photosynthesis? Explain your answer. Refer to Module 2 if necessary.

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②

5. When a lamp is turned off, is it luminous or non-luminous? Explain your answer.

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①

6. Circle the letter of the best response.

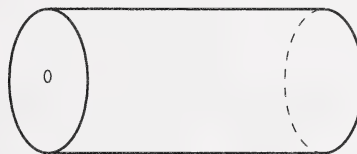
Which property best describes waxed paper?

- A. transparent
- B. opaque
- C. clear
- D. translucent

⑦

7. A pinhole camera can make images of objects.

- a. Starting with the two pictured elements, complete a proper scientific diagram based on the ray model of light. The diagram is to show how an image of the flame would form in the pictured pinhole camera. Include a title and label your diagram. Draw it neatly and in pencil.



①

- b. Is the image formed on the screen upright or inverted?

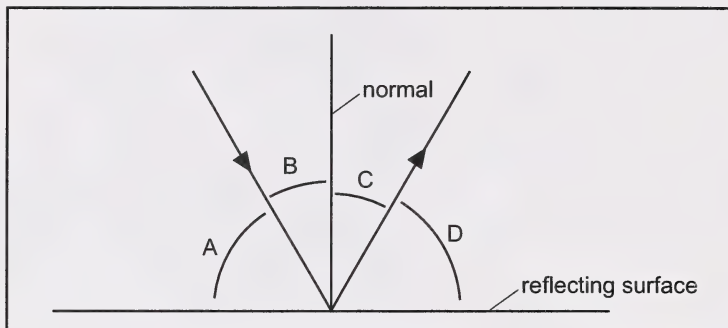
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①

- c. Name the basic property of light on which the ray model is based.

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Use this ray diagram to answer question 8. The ray diagram shows a light ray reflected from a smooth surface.



①

8. Circle the letter of the best response.

Which angle is the angle of incidence?

- A. Angle A
- B. Angle B
- C. Angle C
- D. Angle D

①

9. Think of the image formed by a plane mirror. How does the object distance compare to the image distance?

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10. Light can reflect off rough surfaces.

①

- a. Are the laws of reflection valid for a rough surface?

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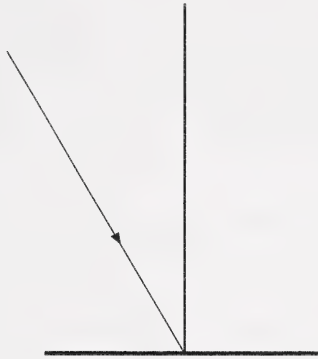
②

- b. Describe what happens when light strikes a rough surface.

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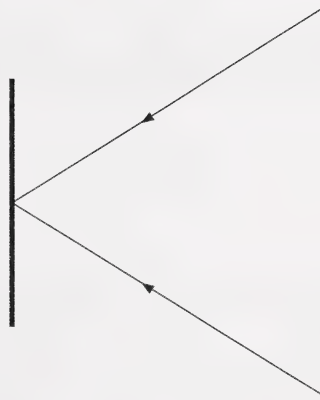
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11. Use the following diagram to answer questions a and b.



- ① a. Draw the reflected ray on the diagram above.
- ① b. The measurement of the angle of reflection is \_\_\_\_\_. (The answer should be in degrees.)

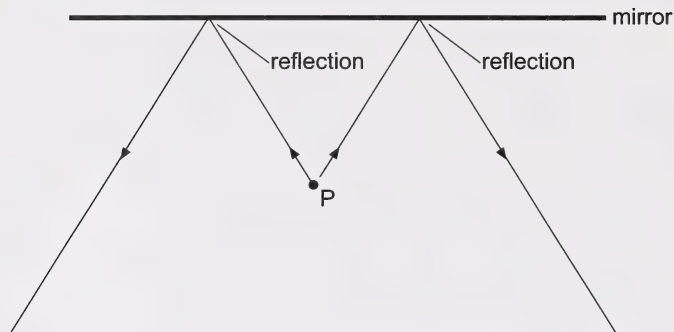
12. Use the following diagram to answer questions a, b, and c.



- ① a. Draw and label the normal for the ray diagram.
- ① b. The measurement of the angle of incidence is \_\_\_\_\_. (Answer in degrees.)
- ① c. The measurement of the angle of reflection is \_\_\_\_\_. (Answer in degrees.)

③

13. Use the following diagram to answer the question.



On the diagram, find the image of pin P by using the reflected rays. Draw the image position. On the diagram, show how you found the location of the image.

Return to page 27 of the Student Module Booklet and continue with Lesson 3.

②

14. What usually happens when a light ray goes from one medium to a denser medium? Base your answer on the law of refraction.

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①

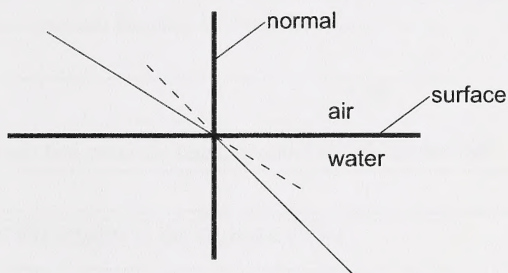
15. Circle the letter of the best response.

For which angle of incidence does light **not** bend as it goes from one medium into another?

- A.  $0.0^\circ$
- B.  $10^\circ$
- C.  $11^\circ$
- D.  $30^\circ$

Use the following information to answer question 16.

A student sketched the following ray diagram to show the path of light at the edge of a water-filled container. The student extended the rays with dotted lines. The dotted lines were intended to show how far the rays were off a linear path due to refraction. However, the student included no arrowheads to show which way the light actually travelled.



- 3 16. Is it possible to use the law of refraction to figure out which way the arrowheads should go on the rays? Explain.

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- 4 17. Based on your investigation of refraction, complete the following table.

Situation	Refraction Pattern
ray crosses the boundary from a more to a less dense medium	ray bends _____ the normal
ray crosses the boundary from a less to a more dense medium	ray bends _____ the normal
increased angle of incidence	_____ angle of refraction
the greater the difference in the densities of the mediums	the _____ the change in the ray's direction as it crosses the boundary between mediums

18. In an investigation, some ocean water was placed in a transparent, rectangular container. A light ray was made to go into the water sample. The angle of incidence was  $30^\circ$ . The container was then filled with distilled water. Again, a light ray was made to go into the water sample at the same angle of incidence.

③

- a. For which sample of water would the light ray bend the most? Explain.

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②

- b. What was the manipulated variable and the responding variable in the investigation?

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**Submit your completed Assignment Booklet 3A to your teacher for assessment.**  
Then return to page 37 of the Student Module Booklet and begin Section 2.

## ASSIGNMENT BOOKLET DECLARATIONS

The Student's Declaration is to be signed by a student registered at the Alberta Distance Learning Centre. If the student is under 16, the Supervisor's Declaration is to be signed by the student's supervisor, who is usually a home instructor, teacher, or home-schooling coordinator. Failure to complete this page may invalidate the assignment results.

### STUDENT'S DECLARATION

- I have followed the instructions outlined in the Student Module Booklet.
- I have completed the activities to prepare myself for the assignments in this Assignment Booklet.
- I completed the assignments in this Assignment Booklet by myself.

\_\_\_\_\_  
Student's Signature

### SUPERVISOR'S DECLARATION

I hereby certify that I have supervised the learning activities completed by \_\_\_\_\_.  
Student's Name

I also certify that to the best of my knowledge the assignments in this Assignment Booklet were completed independently by this student.

\_\_\_\_\_  
Supervisor's Signature

If you, the student or supervisor, have any comments or observations regarding this module, write them in the following space.

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